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DEVICE FOR THE SEPARATE, ENCAPSULATED RECEPTION OF A PLURALITY OF LIKE OR DIFFERENT SUBSTANCES

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Publications considered for determining patentability:	DE 1 96 10 293 C1 DE 35 20 416 C2 DE 39 19 042 A1 DE 39 15 920 A1 DE 38 18 614 A1

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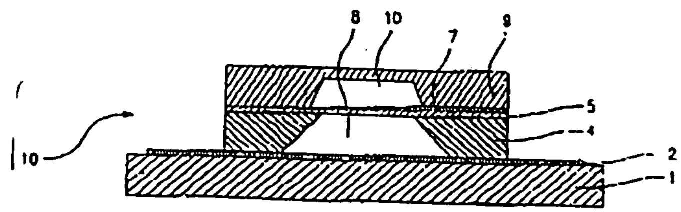
[Abstract]

In a device for the separate, encapsulated reception of a plurality of like or different substances in a plurality of closed hollow spaces in a micromechanically manufactured structure at least two of the hollow spaces are separated by a membrane implemented with microsystem technology or thin-film technology. In addition, the device comprises and electrically actuatable heating device for destroying the membrane in order to connect at least two hollow spaces.



Specification

The present invention relates to a further development of a device for the encapsulated reception of a material in accordance with DE 196 10 293 C1 (not published).

Sensitive materials, e.g., chemical indicator materials, catalysts, or medicaments are used in many areas. The term "sensitive" means that the lifetime, that is, the ability to be used for a certain purpose, is reduced upon contact with a certain substance or mixture of substances. Due to this limited lifetime, it is desirable to release these materials only shortly before they are used in the harmful measuring medium and to preserve them up to this point under a protective gas or protective liquid or a vacuum. The harmful measuring medium can be identical with the substance to be measured.

Customary methods to this end are the encapsulating of the substance in a glass flask, plastic foils or similar packaging. These methods have many disadvantages: the encapsulation methods can be miniaturized only to a limited extent and/or the closure cannot be opened automatically or only opened automatically in a costly manner. Such sensitive substances are also enclosed in a container that is connected to the external environment via a valve and/or hose system. This device is to be automatically opened; however, the speed of the mechanical opening can be insufficient for many applications. Therefore, a reaction to rapid processes is not possible. Moreover, the necessary mechanism limits the minimally achievable construction size and cost reduction.

The direct coating of the substance to be protected with, e.g., electrically vaporizable materials can be used only in a very limited manner since this method results in many instances in an irreversible contamination of the coated material.

DE 39 19 042 A1 discloses a system for analyzing solid substances on mercury. In this known system a solid substance to be analyzed is placed in a container that is subsequently closed by a membrane. When a cover is set over the membrane onto the container edge, the membrane is destroyed by heating of the solid substance and an overpressure in the container caused by said heating. However, the device used in the system disclosed in DE 39 19 042 A1 is not suitable for industrial-scale manufacture.

DE 35 20 416 C2 describes a device for the regulatable opening of a separating wall. This separating wall consists of a membrane set in a clamping ring and with heating wires on it that cause the membrane to open when electrical energy is supplied. Even this device is not suitable for mass production, e.g., by means of micromechanical methods.

DE 38 18 614 and DE 39 15 920 A1 disclose micromechanical structures with a plurality of recesses for receiving small amounts of material, especially in the area of biotechnology. The recesses are closed by a cover that preferably has elevations corresponding with the recesses.

There are, e.g., a great number of transducer designs for detection of substances in gases or liquids. Many operate according to the principle of resistance measuring or capacitance measuring of the indicator material. Refer regarding such transducer designs to H.-E. Endres, S. Rost, H. Sandmaier, "A PHYSICAL SYSTEM FOR CHEMICAL SENSORS," Proc. Microsystem Technologies, Berlin, 10-29 to 11-1-91, 70-75. A change of this dimension (these dimensions) is correlated with an event in the medium to be investigated. The structures necessary for, e.g., resistance measuring, e.g., interdigital structures, are often applied in a thin-film technique onto a substrate, e.g., silicon or quartz. The carrier of these sensors can also be a membrane structure itself.

The production of thin membrane structures, e.g., Si_3N_4 on Si carrier material and other combinations has been known for years from microsystem technology. In general, these membrane structures are used on account of their very low thermal capacity and/or thermal conductivity. They serve as carrier material for temperature-sensitive resistors, e.g., in the realization of thermal flowthrough meters and/or for the thermal insulating of a heating element from its environment.

The invention has the problem, starting from the cited state of the art, of creating a miniaturizable device that makes possible the automatic mixing of two substances which mixing can be regulated by event or by time.

This problem is solved by a device with the features of Claim 1.

The present invention creates a device for the separate, encapsulated reception of a plurality of like or different substances in a plurality of closed hollow spaces in a micromechanically manufactured structure, at least two of which hollow spaces are separated by a membrane implemented with microsystem technology or thin-film technology, and which device comprises an electrically actuatable heating device for destroying the membrane in order to connect the at least two hollow spaces.

The micromechanically manufactured structure can be formed with preference by a plurality of semiconductor slices that are connected in such a manner that at least two recesses in the semiconductor slices are separated by the membrane implemented with microsystem technology or thin-film technology. Furthermore, such a micromechanically manufactured structure can comprise a plurality of membranes, each of which separates at least two hollow spaces in the micromechanically manufactured structure. The plurality of membranes can then be destroyed substantially at the same time or staggered in time by a suitable drive device for driving the electrically actuatable heating devices.

The membrane used in the present device can preferably be provided with a protective coating that makes it possible to house aggressive media. If the membrane consists, e.g., of silicon nitride, e.g., silicon carbide can be used as a resistant protective coating.

The device makes use of the fact that rather high tension forces frequently occur in thin membranes implemented in thin-film technology or microsystem technology that are considered as a problem of such membrane structures in other areas of technology. These tension forces present in the membrane cause an explosive bursting of the membrane when thermal forces are applied onto the membrane. The membrane does not vaporize thereby but rather bursts into individual pieces. The heating device used in accordance with the present invention is preferably executed as a heater integrated on the membrane and in which a short heating impulse brings about a thermal tensioning of the membrane that causes this membrane to burst.

The structures used in the device offer a simple, rapid, contamination-free way of mixing a plurality of substances located in different hollow spaces. The structure is readily accessible for industrial-scale technology. The orderly destruction of the membrane can be signalized by a suitable electrode geometry. The present invention thus makes use of a structure that can be implemented with current industrial-scale technical methods. The basic membrane body structure is advantageously executed using microsystem technology. However, for the purposes of the invention the membrane can also be executed using thin-film technology.

The sole figure shows a schematic cross sectional view of an exemplary embodiment of the device for the separate, encapsulated reception of a plurality of like or different substances.

The device, that is designated with reference numeral 20, comprises a carrier 1 consisting, e.g., of quartz. A coating 2 is optionally applied onto carrier 1 which coating can

serve, e.g., to support a connection of carrier 1 to a semiconductor slice that consists of silicon in the preferred exemplary embodiment and into which a recess 8 has been worked by customary photolithographic and etching methods. Membrane 5 is formed above recess 8. An expert in the art of microsystem technology requires no explanation that methods of producing a membrane spanning a semiconductor structure are customary in microsystem technology and that in this instance membrane 5 is customarily applied at first onto semiconductor structure 4 before recess 8 is formed in semiconductor structure 4 by photolithographic and etching measures.

Heating structure 7 that communicates via connection leads with terminal pads or bond pads is arranged on membrane 5.

Another slice 9 consisting of silicon in the preferred exemplary embodiment is arranged on the surface of membrane 5 opposite carrier structure 4. Slice 9 exhibits recess 10 and is connected to slice 4 via membrane 5 in such a manner that hollow spaces 8 and 10 oppose each other and are separated by membrane 5.

If, e.g., a substance A is introduced into hollow space 8 during the manufacture of the device while a substance B is introduced into hollow space 10, a mixing of the two substances and therewith, e.g., a certain reaction can be brought about automatically by actuating electric heating device 7.

It is obvious for experts skilled in the art that the exemplary embodiment shown in the figure is purely illustrative. For example, recess 10 arranged in slice 9 could completely penetrate it, in which instance this recess is sealed off on the top by another membrane bordering on a recess of another slice. In this manner, e.g., a structure can be produced comprising more than two hollow spaces separated from one another by a membrane.

The device thus makes it possible to separate a certain number of substances into two or more chambers or recesses separated by "membrane technology." Such a structure can be achieved in that the encapsulation either comprises several chambers and membranes in the manufacture already or, alternatively, the elements are appropriately combined at the slice or individual-part level, e.g., by slice bonding or adhesion. A certain number of chambers can be opened quasi simultaneously (in the millisecond range) or also staggered as desired in time as a function of the design and the desired reaction by controlling the individual heating devices in an appropriate manner. Thus, the number of, e.g., chemical reactions, e.g., detection reactions, possible within a membrane system can be greatly increased by a multi-chamber technology.

The membrane can be provided with a resistant protective coating as a function of the use. If the membrane consists of silicon nitride a coating of silicon carbide can be used in a suitable form as protective coating. This makes it possible to use the membrane even in aggressive media, e.g., strong acids. Given an appropriate selection of material and material thickness, this protective layer does not adversely impact the operation of the system, that is, it

does not destroy the membrane. In contrast thereto, mechanically moved parts like those contained in pumps are in general more difficult to cover with protective coatings.

Claims

1. A device (10) for the separate, encapsulated reception of a plurality of like or different substances in a plurality of closed hollow spaces (8, 10) in a micromechanically manufactured structure, at least two of which hollow spaces (8, 10) are separated by a membrane (5) implemented with microsystem technology or thin-film technology, and which device (10) comprises an electrically actuatable heating device (7) for destroying the membrane (5) in order to connect the at least two hollow spaces (8, 10).

2. The device according to Claim 1 in which the micromechanically manufactured structure is formed by at least two semiconductor slices (4, 9) connected in such a manner that at least two recesses (8, 10) in the semiconductor slices (4, 9) are separated by the membrane (5) implemented with microsystem technology or thin-film technology.

3. The device according to Claim 1 or 2 comprising a plurality of membranes implemented with microsystem technology or thin-film technology and separating at least two hollow spaces in the micromechanically manufactured structure, which device comprises an electrically actuatable heating device for each membrane for destroying this membrane and which device exhibits a drive device with which the electrically actuatable heating devices can be driven in order to destroy the plurality of membranes substantially simultaneously or staggered in time.

4. The device according to one of Claims 1 to 3 in which the membrane or at least one of the plurality of membranes is provided with a protective coating.

5. The device according to one of Claims 1 to 4 in which the membrane or the plurality of membranes consists of silicon nitride.

6. The device according to Claim 4 or 5 in which the protective coating consists of silicon carbide.

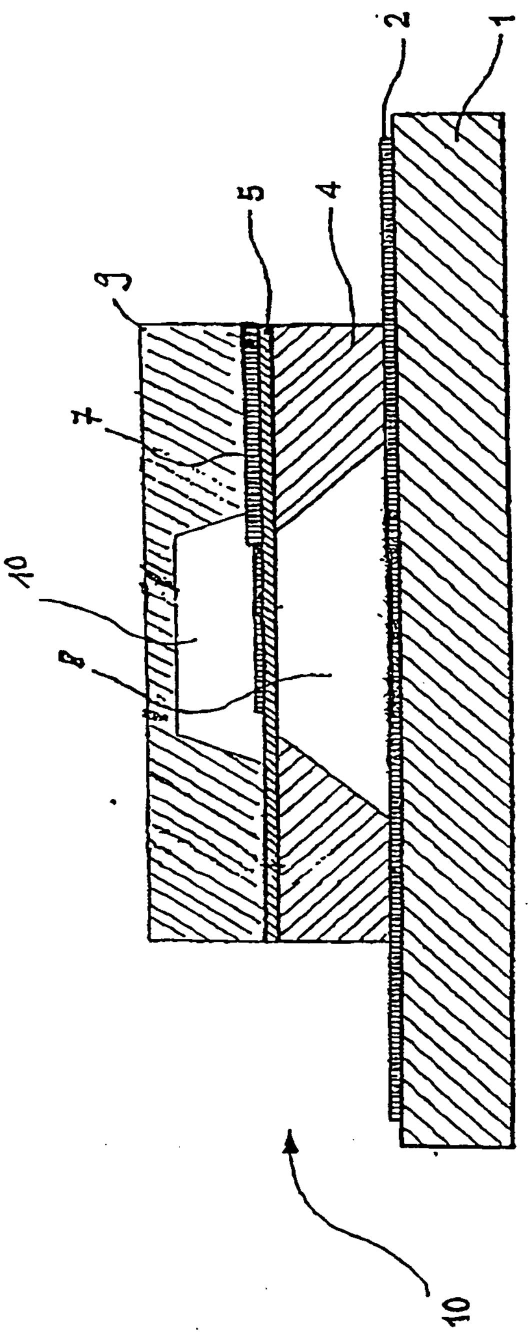


FIG.